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(71) Applicant: **THOR CERAMICS LIMITED**
P.O. Box 3 Stanford Street
Clydebank Dunbartonshire G8I 1RW
Scotland(GB)

(72) Inventor: **Lee, Stephen John**
6 River View Crescent
Cardross G51 5LT Scotland(GB)

(74) Representative: **Wotherspoon, Graham et al**
FITZPATRICKS 4 West Regent Street
Glasgow G2 1RS Scotland(GB)

(54) **Refractory assemblies.**

(57) A refractory pouring assembly (4, 6, 7, 9; 23, 24, 26, 27, 29; 33, 34, 39) comprises at least one refractory component having a jointing surface adapted to mate with a corresponding surface of another component of the assembly and to which there may be applied primary and secondary, mutually spaced deposits of cement sealant (11, 12; 15, 16; 36, 37), wherein said jointing surface is provided with a recess (5, 8, 13; 25, 28; 35) for receiving a meltable sealing composition which melts under pouring conditions to form a reactive material of initially low viscosity and which reacts under pouring conditions to form a sealing material of high viscosity which in use provides an additional seal between said primary and secondary sealants. The joint-sealing composition comprises a mixture of a low melting (say within 500°C to 650°C) reactive glass e.g. at least 25% borosilicate glass, with a filler, which may be ceramic fibres or a clay.

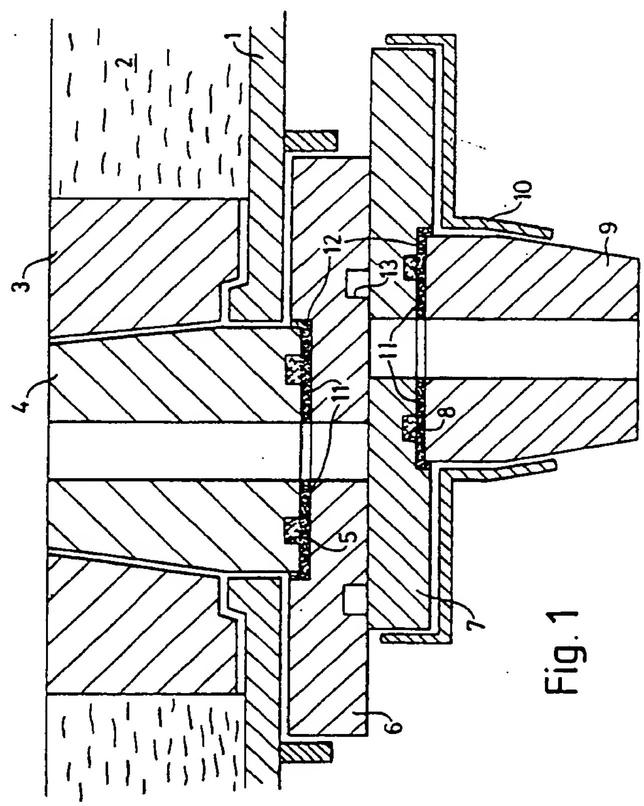

Fig. 1

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Refractory Assemblies

This invention relates to refractory products for use in steel casting. More particularly the invention is concerned with sealing of joints between refractory products used in pouring of melt from, for example, the tundish to the mould. Flow of melt from the tundish into a mould is commonly controlled by raising or lowering of a refractory stopper rod from or to a seating position in the base of the tundish where there is located either a fixed sub-entry nozzle (SEN) or a detachable sub-entry shroud (SES) fastened underneath the tundish onto a nozzle built into the base of the tundish. In place of stopper rod valve closures, a slide gate control mechanism to which the SES is attached is also known. This invention is particularly concerned with improving the sealing of components making up such pouring assemblies.

It is known to seal joints between ceramics using refractory cements which may be air-or heat-setting cements. In modern casting operations, there are many instances where joints must remain separable, yet be sufficiently gas-tight as to avoid ingress of air drawn in by the pressure differential between the interior of the pouring assembly and ambient caused by downrush of molten metal in the assembly. Great efforts are made to provide precision formed ceramics which are capable of being interconnected to provide good joints, but perfect gas-tight joints are difficult to achieve. At present this problem is most often met by enveloping the joint in an inert gas. However this has a cost disadvantage in that the expensive inert gas (e.g. argon) is not fully recovered and the gas jetting or enveloping systems add to the expense of the equipment, not only in material but also in control and maintenance costs.

Recently some steelmakers have been fitting to the underside of the tundish a fairly simple mechanism which enables quick changeover of pouring tubes to minimise loss of time and production in replacing worn or damaged tubes. Such a tube-changer is described in GB 1 597 215 whilst another is disclosed in EP-A-0 192 019. When an SES is cracked or worn out the mechanism rapidly pushes out the used piece and drives a new tube into alignment underneath the metal stream, for example by means of a piston arrangement. It will be appreciated that this operation is not without risk of physical damage to the refractory surfaces. This is only one example of an instance where a releasable gas-tight seal has to be provided.

Whilst improvements have been made in the tube changing mechanisms since their introduction, there remain problems in ensuring adequate fitting of the respective mating surfaces of the tube, upper and lower plates of the tube changer and the block or nozzle in the base of the tundish. If improper fitting of these refractory components occurs then air/oxygen leakage through the misfitting joints is possible with detrimental effect upon the quality of the steel. Air/oxygen penetrating the joints reacts with the alumina in the steel leading to build up of alumina deposits and clogging of the pouring tube. Such reaction also yields a problem manifesting itself as inclusions in the casting commonly identified as black spot.

Thus those in this field have hitherto sought to mitigate such problems by seeking to improve (a) the ceramic/metal ceramic/ceramic joints, (b) the inert gas delivery systems and (c) handling and change-over systems leading to ever more complex and expensive pouring systems.

An object of the present invention is to obviate or mitigate the aforementioned problems by providing improved pouring assemblies suitable for use in conjunction with bottom pouring metallurgical vessels and related equipment.

Accordingly the present invention provides a refractory pouring assembly comprising at least one refractory component having a jointing surface adapted to mate with a corresponding surface of another component of the assembly and to which there may be applied primary and secondary, mutually spaced deposits of cement sealant, wherein said jointing surface is provided with a recess for receiving a meltable sealing composition which melts under pouring conditions to form a reactive material of initially low viscosity and which reacts under pouring conditions to form a sealing material of high viscosity which in use provides an additional seal between said primary and secondary sealants. Preferably the composition is a mixture of a low temperature melting reactive glass and a filler material capable of reacting with the glass to thicken it, e.g. made up of ceramic fibres. Preferably also the composition includes an intumescent agent to ensure filling of voids by the sealing composition. The recess(es) in which the composition is first located need not not be of any great depth and the shape is not often critical. Thus for a sub-entry shroud (SES) type of pouring tube which has an upper surface having a circular area, the recess may be an annular groove on that surface,or a plurality of such grooves, or a series of holes forming a ring of recesses on that surface. Where a lower surface of a tundish nozzle, which normally mates with an upper surface of an SES for example is provided with recesses for the composition, the composition does not flow until the assembly comes up to pour operating temperatures. Thus the

pool of fluid seal becomes entrapped between the lower tundish nozzle surface and the upper SES surface in use. However where the SES is to be replaced, whether or not by a tube changer, the fluid seal must be broken. Although after the initial operating period the viscosity will be raised by the reaction of glass with filler, it may not be certain that replacement of the SES will enable restoration of the previously good seal. In such an instance it may be necessary to apply a small quantity of the composition around the upper surface of the new SES prior to fitting to make up the fluid seal upon recommencing of pouring through the new assembly.

Further according to this invention there is provided a joint-sealing composition for use with refractory components in a pouring assembly for casting of metals comprising a mixture of a low temperature melting reactive glass with a filler material, which may be ceramic fibre based or a clay or the like material.

Preferably the mixture is at least 25% glass and melts within the temperature range of from 500°C to 650°C. The glass may be any one of the borosilicate glasses.

In normal use of the composition of this invention within a steel pouring assembly, upon melting, the composition will fill the recess(es) in the refractory surface(s) and tend to seep into potential gas channels thereby presenting a fluid pool barrier to gas ingress. The flow of the composition will in the simplest case, depending upon the orientation of the refractory components, be for the most part under the influence of gravity. Bearing this in mind, best use of the composition may be made by selecting recess positions to act as composition reservoirs on downward facing surfaces of the refractory components. However in order to ensure filling of voids in parts which have joints which prevent such selection an intumescent agent which will ensure adequate filling of voids between jointing surfaces may be added to the composition. Vermiculite, which also acts as a filler, is suitable. Therefore a preferred composition consists of a borosilicate glass and vermiculite. In use, as the melted composition spreads out to fill the voids, the glass component thereof begins to react with the filler material, increasing the viscosity of the composition and retarding its tendency to flow. Thus a tripartite sealant arrangement is formed which (from the throughbore of the pouring assembly outwards), consists of the inner deposit of primary cement sealant, a quantity of the new reactive glass containing sealant and an outer deposit of secondary cement sealant. In this way it is ensured that the voids are first filled and then remain filled because the composition becomes unable to seep away from the joint due to firstly the chemical and physical changes in the composition and secondly by virtue of its intermediate location between the primary and secondary cement sealants (air or heat setting).

The invention will now be further described with reference to the accompanying drawings in which :-

Fig. 1 is a section through a sliding ceramic slide-plate valve pouring assembly incorporating the sealant of this invention ;

Fig. 2 is a section through a pouring tube (SES) assembly incorporating sliding plates for a tube changer mechanism; and

Fig. 3 is a section through a static pouring tube (SES) assembly.

Example 1.

Referring to Fig. 1 of the drawings, a pouring assembly is provided for a tundish (1) which has a lining (2) in which there is located a block (3) to which the pouring assembly is attached. This assembly comprises an upper nozzle (4) located in the well block (3) and having a lower surface thereof mating with a corresponding stationary plate (6) fixed beneath the tundish (1). A lower plate (7) is supported in sliding contact with the stationary plate (6) by slide carrier (10) and handling means (not shown). A lower surface of the sliding plate (7) is adapted to mate with a collector nozzle (9) which provides the lowermost part of the pouring assembly. The nozzles (4) and (9) have axial throughbores and the plates (6) and (7) have central apertures which may be brought into alignment to allow a pouring conduit to be formed by the assembly by appropriate control of the sliding plate (7).

The upper nozzle (4) and stationary plate (6) are joined using a refractory jointing compound in the usual way. However in this embodiment of the invention, the refractory components described above are modified to provide a means of including an additional sealant. The lower surface of the nozzle (4) is provided with an annular recess (5) or series of recesses surrounding the throughbore therein for receiving the said sealant. This sealant is a composition of fillers and a borosilicate glass (30% by weight) which melts at pouring temperatures to give a low viscosity fluid reactive mixture which seeks and enters potential paths of air ingress before subsequent reaction with the filler phase yields a higher viscosity medium which seals the potential paths of air ingress. In use a primary sealant (11) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (4) and the upper surface of the stationary plate (6) adjacent to the throughbore, the

additional meltable fluid sealant of this invention is provided in the recess (5), and a secondary or back-up sealant (12) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (4) and the upper surface of the stationary plate (6). The jointing compound may conveniently be applied to the upper surface of the stationary plate (6) whilst the additional sealant is deposited in the recess (5) before assembly, although other methods may be used. Similarly, the lower surface of the stationary plate (6) is provided with a recess (13) for receiving the fluid sealant of this invention but since this plate is part of a sliding assembly the jointing compound is absent. The sliding plate (7) has on a lower surface an annular recess or series of recesses (8) for receiving a meltable fluid sealant similar to that used for the upper nozzle (4)/upper plate (6) joint. As for the said upper parts of the assembly, a primary sealant (11) and secondary sealant (12) of refractory jointing cement is applied on either side of the recess (8) to provide in use a tripartite sealed joint between the collector nozzle (9) and the slide plate (7).

Example 2

Referring to Fig. 2 of the drawings, a pouring tube/changer assembly is provided for a tundish (21) which has a lining (22) in which there is located a block (23) to which the pouring assembly is attached. This assembly comprises an upper nozzle (24) which is adapted to provide seating for a stopper (20) and which is located in the well block (23) and having a lower surface thereof mating with a corresponding stationary plate (26) fixed beneath the tundish (21). A lower plate (27) is supported in sliding contact with the stationary plate (26) by member (30) within housing (14) . A lower surface of the sliding plate (27) is adapted to mate with a sub-entry pouring tube (29) which provides the lowermost part of the pouring assembly. The nozzle (24) and tube (29) have axial throughbores and the plates (26) and (27) have central apertures which may be brought into alignment to allow a pouring conduit to be formed through the complete assembly.

The upper nozzle (24) and stationary plate (26) are joined using a refractory jointing compound in the usual way. As for Example 1, the refractory components described above are modified to provide a means of including an additional sealant. The lower surface of the nozzle (24) is provided with an annular recess (25) or series of recesses surrounding the throughbore therein for receiving the said sealant. This sealant is a composition of fillers and a borosilicate glass (30% by weight) which which melts at pouring temperatures to give a low viscosity fluid reactive mixture which seeks and enters potential paths of air ingress before subsequent reaction with the filler phase yields a higher viscosity medium which seals the potential paths of air ingress. In use a primary sealant (15) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (24) and the upper surface of the stationary plate (26) adjacent to the throughbore, the additional meltable fluid sealant of this invention is provided in the recess (25), and a secondary or back-up sealant (16) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (24) and the upper surface oftionry plate (26). The jointing compound may conveniently be applied to the upper surface of the stationary plate (26) whilst the additional sealant is deposited in the recess (25) before assembly, although other methods may be used. Similarly, the lower surface of the stationary plate (26) is provided with a recess (13) for receiving the fluid sealant of this invention but since this plate is part of a sliding assembly the jointing compound is absent. The sliding plate (27) has on a lower surface an annular recess or series of recesses (28) for receiving a meltable fluid sealant similar to that used for the upper nozzle (24)/upper plate (26) joint. As for the said upper parts of the assembly, a primary sealant (15) and secondary sealant (16) of refractory jointing cement is applied on either side of the recess (28) to provide in use a tri-partite sealed joint between the sub entry pour tube (29) and the slide plate (27).

Example 3

Referring to Fig. 3 of the drawings, a static pouring tube assembly is provided for a tundish (31) which has a lining (32) in which there is located a block (33) to which the pouring assembly is attached. This assembly comprises an upper nozzle (34) which is adapted to provide seating for a stopper (30) and which is located in the well block (33) and has a lower surface thereof adapted to mate with a sub-entry pouring tube (39) with a slag-line wear-resistant surface (40) which tube is held in position by suitable support means (38) and provides the lowermost part of the pouring assembly. The nozzle (34) and tube (39) have axial through-bores which allow pouring through the complete assembly.

As for the previous Examples, the refractory components described above are modified to provide a means of including an additional sealant. The lower surface of the nozzle (34) is provided with an annular recess (35) or series of recesses

surrounding the throughbore therein for receiving the said sealant. This sealant is a composition of fillers and a borosilicate glass (30% by weight) which melts at pouring temperatures to give a low viscosity fluid reactive mixture which seeks and enters potential paths of air ingress before subsequent reaction with the filler phase yields a higher viscosity medium which seals the potential paths of air ingress. In use a primary sealant (36) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (34) and the upper surface of the pouring tube (39) adjacent to the through-bore, the additional meltable fluid sealant of this invention is provided in the recess (35), and a secondary or back-up sealant (37) consisting of a refractory jointing compound is deposited between the lower surface of the nozzle (34) and the upper surface of the pouring tube (39). The jointing compound may conveniently be applied to the upper surface of the pouring tube (39) whilst the additional sealant is deposited in the recess (35) before assembly, although other methods may be used to provide in use a tri-partite sealed joint between the sub entry pour tube (39) and the nozzle (34).

Claims

1. A refractory pouring assembly (4, 6, 7, 9; 23, 24, 26, 27, 29; 33, 34, 39) comprising at least one refractory component having a jointing surface adapted to mate with a corresponding surface of another component of the assembly and to which there may be applied primary and secondary, mutually spaced deposits of cement sealant (11, 12; 15, 16; 36, 37), characterised in that said jointing surface is provided with a recess (5, 8, 13; 25, 28; 35) for receiving a meltable sealing composition which melts under pouring conditions to form a reactive material of initially low viscosity and which reacts under pouring conditions to form a sealing material of high viscosity which in use provides an additional seal between said primary and secondary sealants.

2. A refractory pouring assembly according to claim 1 wherein the composition is a mixture of a low temperature melting reactive glass and a filler material capable of reacting with the glass to thicken it.

3. A refractory pouring assembly according to claim 2 wherein the filler material comprises ceramic fibres.

4. A refractory pouring assembly according to claim 1 wherein the composition includes an intumescent agent to ensure filling of voids by the sealing composition.

5. A refractory pouring assembly according to claim 4 wherein said composition comprises vermiculite.

6. A refractory pouring assembly according to any one of claims 1 to 5 wherein the said meltable composition is provided in an annular groove or series of recesses (5, 8, 13) in a mating surface of the assembly.

7. A joint-sealing composition for use with refractory components in a pouring assembly for casting of metals comprising a mixture of a low temperature melting reactive glass with a filler material.

8. A composition according to claim 7 wherein the filler material comprises ceramic fibres or a clay.

9. A composition according to claim 7 or claim 8 wherein the mixture is at least 25% glass and melts within the temperature range of from 500°C to 650°C.

10. A composition according to any one of claims 7 to 9 wherein the glass is a borosilicate glass.

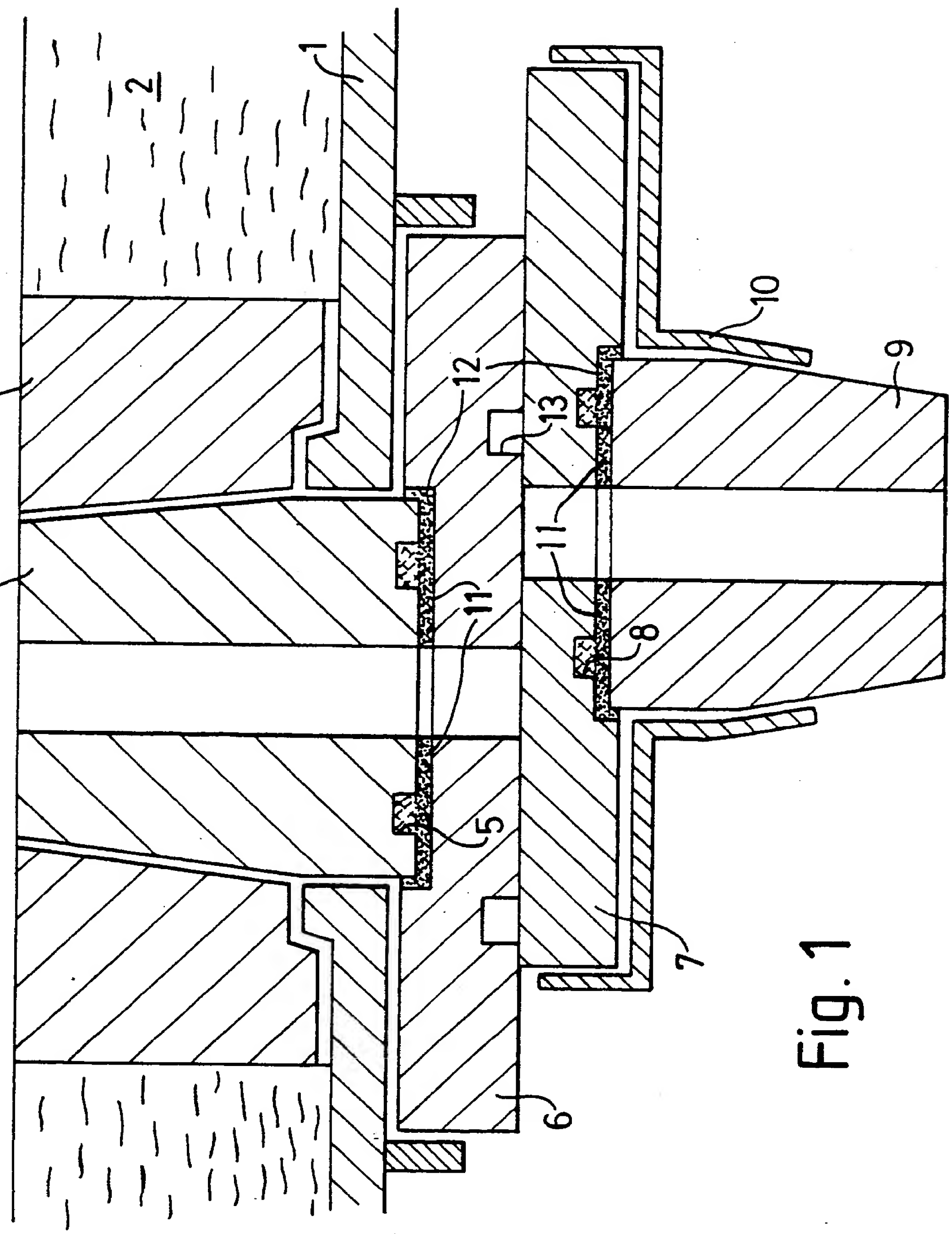

Fig. 1

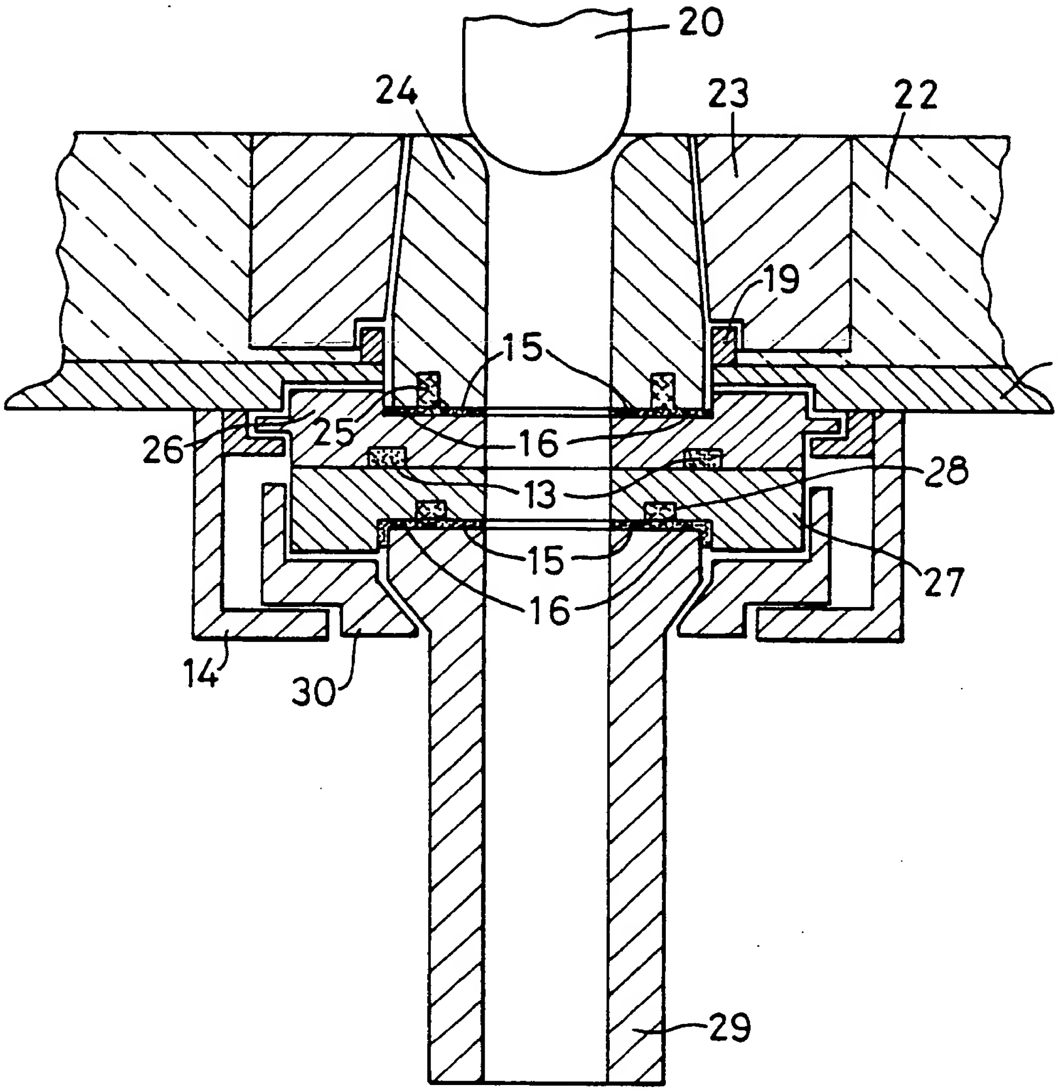

Fig. 2

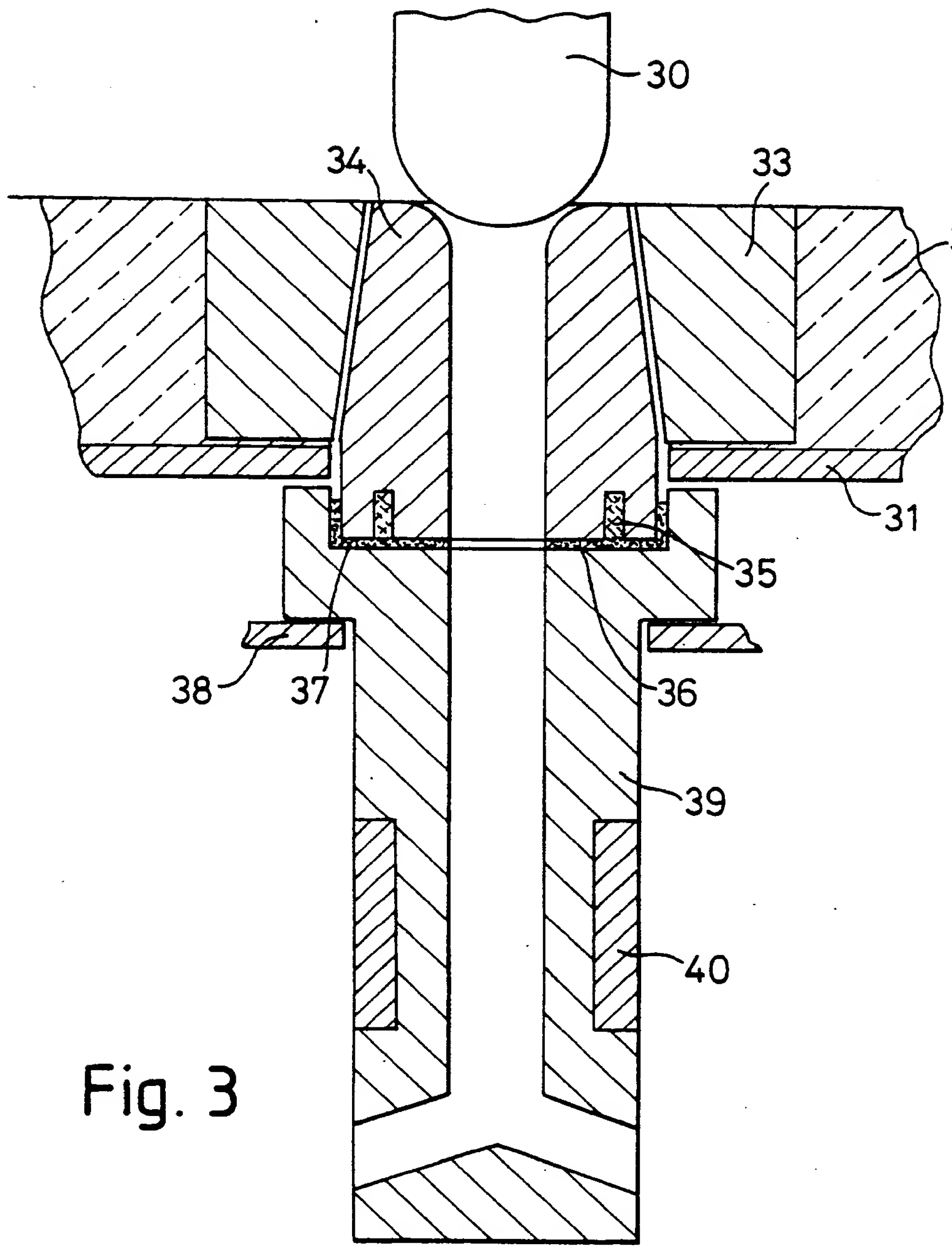

Fig. 3

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EUROPEAN SEARCH REPORT

Application Number

EP 88 30 1946

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
X	EP-A-0 136 733 (BRITISH STEEL CORP.) * Abstract; figures 1,2; page 3, lines 6-28; page 4, line 20 - page 5, line 25 * ---	1,2,7,9,10	B 22 D 11/10 B 22 D 41/08
X	DE-B-2 830 199 (MARTIN & PAGENSTECHER GmbH) * Figures 1,2; column 4, line 16 - column 6, line 9 * ---	1,6	
A	EP-A-0 198 123 (BELREF) ---		
A	PATENT ABSTRACTS OF JAPAN, vol. 11, no. 225 (M-609)[2672], 22nd July 1987; & JP-A-62 40 959 (AKECHI CERAMIC K.K.) 21-02-87 -----		

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

B 22 D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-06-1988	MAILLIARD A.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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